Space Weather Technical Forecast

Issued on Sunday 2 February 2025 at 01:25 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1 Minor Storms Day 1 (01 Feb) with fast solar winds and a potential CME glance. Further M-class flares expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate solar activity over the last 24 hours, with one M-class flare, reaching a peak M2.4 at 01/1319 UTC from AR3977. There are eight active regions on the Earth-facing disc. The majority of the activity is from the cluster of sunspots in the northeast, consisting of AR3976, AR3977 and AR3978. These form a complex area of multiple active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976 has lost its earlier weak delta spot. Meantime, AR3978 has developed a delta region within its intermediate spot. There are a number of small and simpler regions across the rest of the disc, however any growth of these remains generally limited.

A CME observed leaving the Sun associated with the M2.4 flare from the northeast disc was associated with a estimated 264km/s Type II radio sweep. Analysis of this event suggests a likely miss behind and to the north of Earth. A second, multipart CME left the Sun at a similar time from the region of AR3979 in the southwest, early analysis of this events suggests a miss ahead of Earths orbit.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1, showed the onset of a connection to CH11/+. Wind speeds were initially slightly elevated around 400km/s, rising slowly to current strong levels around 680km/s. Density was below average. The Interplanetary Magnetic Field, Bt, initially moderate to strong, peaking at 18nT, but has steadily declined to current weak levels around 5nT. The north-south component, Bz, initially moderately variable, between +14/-12nT, but variation steadily reducing to become weak. Phi angle was positive (Away from the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background levels. The associated 24-hour fluence persisted below the Active threshold, recording 1.32e6 integrated pfu at 02/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is expected, with M-class flares expected at times and a slight chance of isolated X-class flares, primarily from the regions on the northeast disc.

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Solar Wind / Geomagnetic Activity: There is one CME in the forecast, which could give a glance on Day 1 (02 Feb). There is uncertainty in the possible geomagnetic response to this - it is most likely to be a glancing blow with little significant effect, but with potential for something stronger. Earth is currently connecting to the fast wind from CH11/+, and speeds around 600-700km/s. Wind speeds expected to gradually ease during Days 2 and 3 (03-04 Feb), returning to generally slightly elevated levels by Day 4 (05 Feb).

Unsettled to Active geomagnetic activity is expected, with a chance of G1/Minor storms on Day 1 (02 Feb), and a slight chance of a G2/Moderate Storm interval. There is a very slight chance of G3/Strong storms should any CME be more geoeffective. Activity then expected to ease during Days 2-3 (03-04 Feb) to become generally Quiet to Unsettled.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is likely to be at background levels, but with a slightly increasing potential of responding to any notable flares as the sunspot regions in the northeast move towards the western hemisphere. GOES16 high energy electron flux is likely to show a rising trend later in the period, possibly reaching Moderate to High levels by the end of the period. The corresponding 24 hour fluence is expected to persist below the Active threshold Days 1-2 (02-03 Feb), but with an expected rising trend Days 3-4 (04-05 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period

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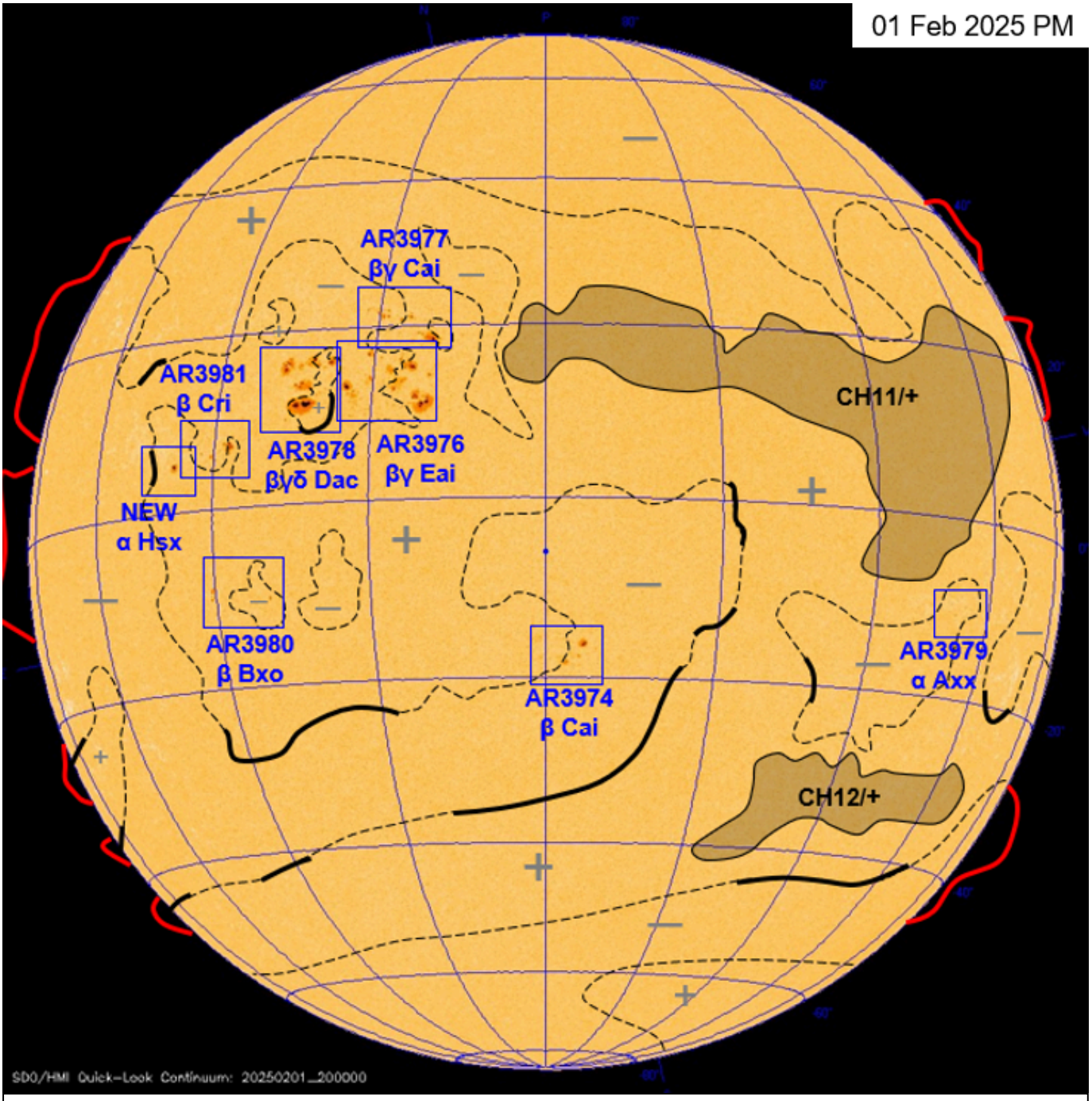
Figure 1: Solar Synoptic Map valid 01/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

One CME currently features in the forecast, however confidence is low. This was from a multi-stage filament eruption off the southeast disc around 30/1400 UTC. This has been modelled as passing mostly behind and south of Earth, however an arrival is possible on Day 1 (02 Feb). There is significant uncertainty in the potential geoeffectiveness of this feature - any arrival would probably be just a glancing blow with little significant effect. However, if we do see some of the main bulk of the CME, it could give a more significant geomagnetic response due to the potential high density from its filament origin. The potential for further CME also remains elevated, with a number of large filaments in potentially geoeffective positions and the large cluster of the sunspots in the northeast continuing to rotate across the disk.

Earth is now connected to the fast wind from CH11/+, a little later than originally expected, with wind speeds now strong at 680-700km/s. While positive polarity coronal holes are generally less favourable for a strong geomagnetic connections at this time of year, the strength of the wind and the persistence of the feature which brought G1/Minor storms on the last rotation, suggest that this could still be a geoeffective feature. Furthermore, peak wind speeds are likely to continue until any arrival of the CME mentioned above, with wind speeds expected to gradually ease during Days 2 and 3 (03-04 Feb), returning to generally slightly elevated levels by Day 4 (05 Feb). This timeframe supported by current MOSWOC ENLIL output, which is providing reasonable guidance at present.

Unsettled to Active geomagnetic activity is expected, with a chance of G1/Minor storms on Day 1 (02 Feb), and a slight chance of a G2/Moderate Storm interval. There is a very slight chance of G3/Strong storms should any CME be more geoeffective. Activity then expected to ease during Days 2-3 (03-04 Feb) to become generally Quiet to Unsettled.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	20	5	5
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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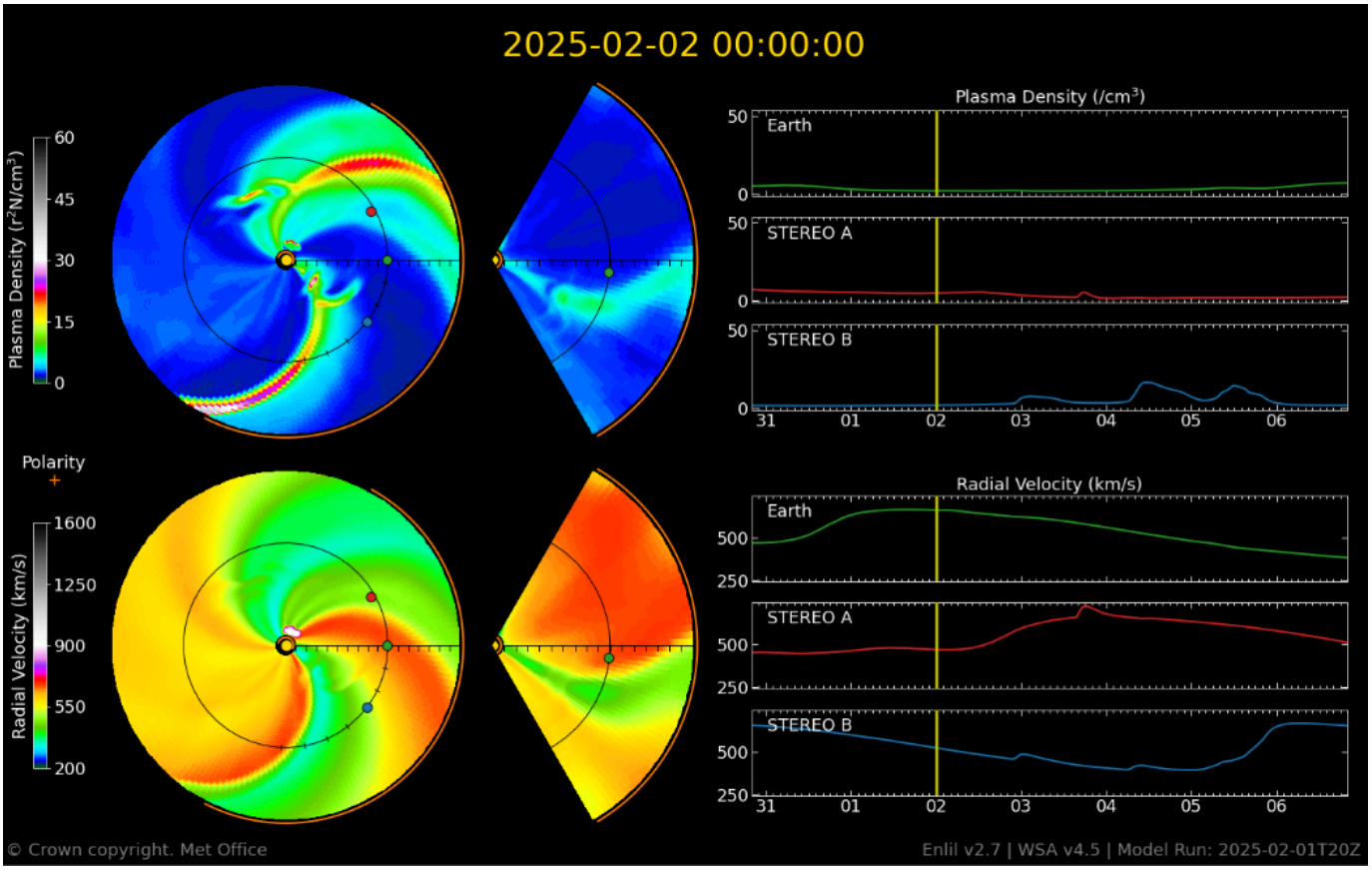
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/2345	Partial	Filament	29E 27S	570	02/1200 +/ 10hrs	Low confidence, probable glancing impact.

Figure 2: Latest MOSWOC ENLIL output.



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Radio Blackouts - X-Ray Flares

There are currently eight active regions on the Earth-facing disc. The majority of the activity is from the cluster of sunspots in the northeast, consisting of AR3976, AR3977 and AR3978. These form a complex area with a proliferation of sun spots, complex magnetic interaction between the different regions and ongoing slow development. Whilst AR3976 seems to have lost its weak delta spot, AR3978 has started to develop one in its intermediate portion. Despite the large amounts of magnetic potential recent flare activity has so far remained fairly muted with the bulk of activity appeared to originate from between AR3976 and AR3978. The remaining regions across the rest of the disc are smaller and simpler with any growth limited.

No significant regions are due to rotate off the disc in the forecast period. Recurrence suggests the potential for returning regions during the period, although far-side helioseismic output has no strong signals. Overall further M-class flares are expected, with the risk maintained throughout the period pending further developments. There is a slight chance of an isolated X-class flare from the cluster in the northeast given its overall size and complexity.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	75	75	75	75
Very Active	R3-R5 (X Class)	No	15	15	15	15

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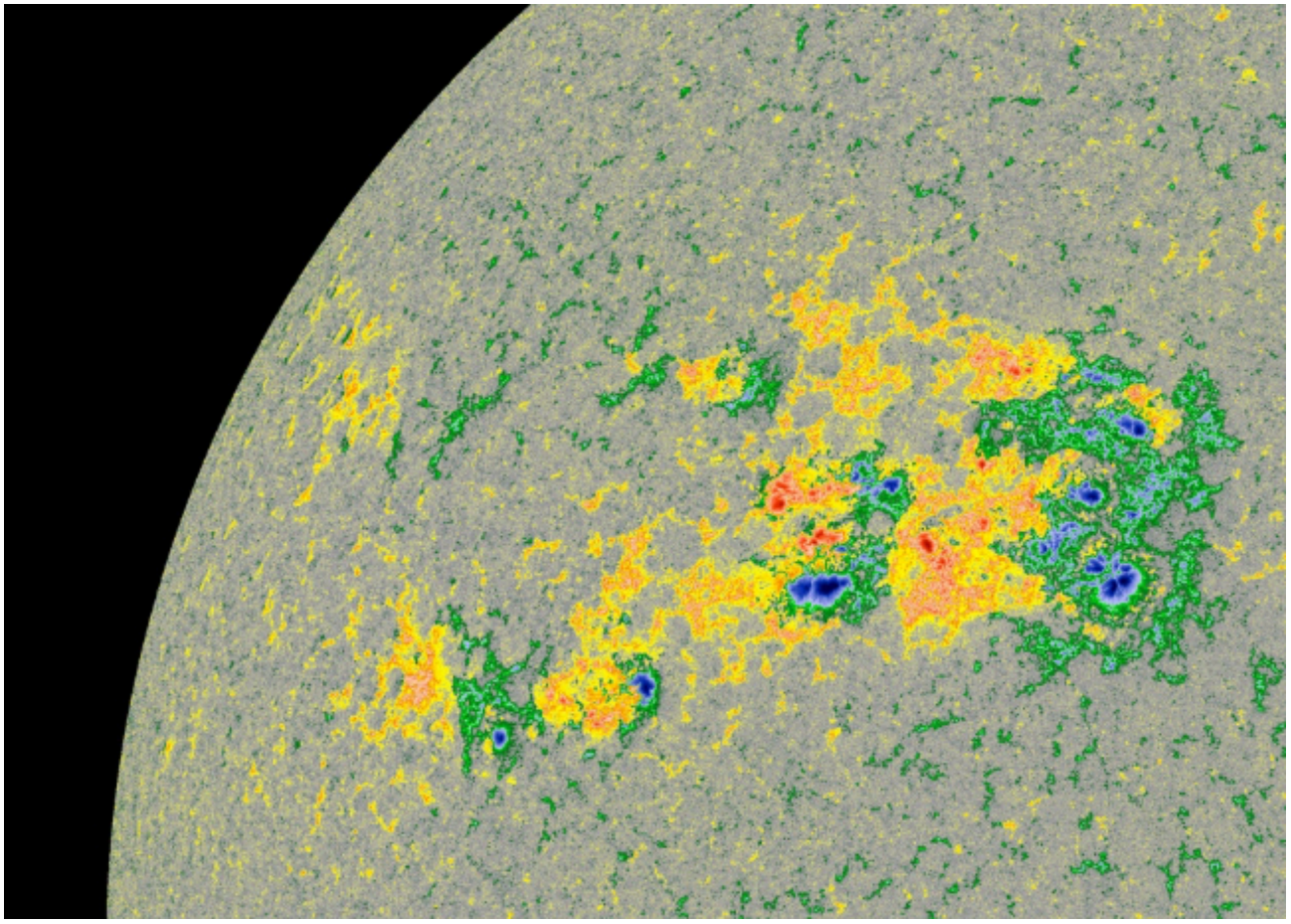
Figure 3: SDO/HMI Magnetogram imagery valid 02/0000UTC, showing the large and complex magnetic structure of the northeast cluster of active regions.



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Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background levels, and is generally likely to remain that way through this forecast period with the majority of the current solar activity on the northeast disc. As these regions move into the centre-disc, and then into the western hemisphere, there is a gradually increasing chance of proton flux rising in response to any notable flares.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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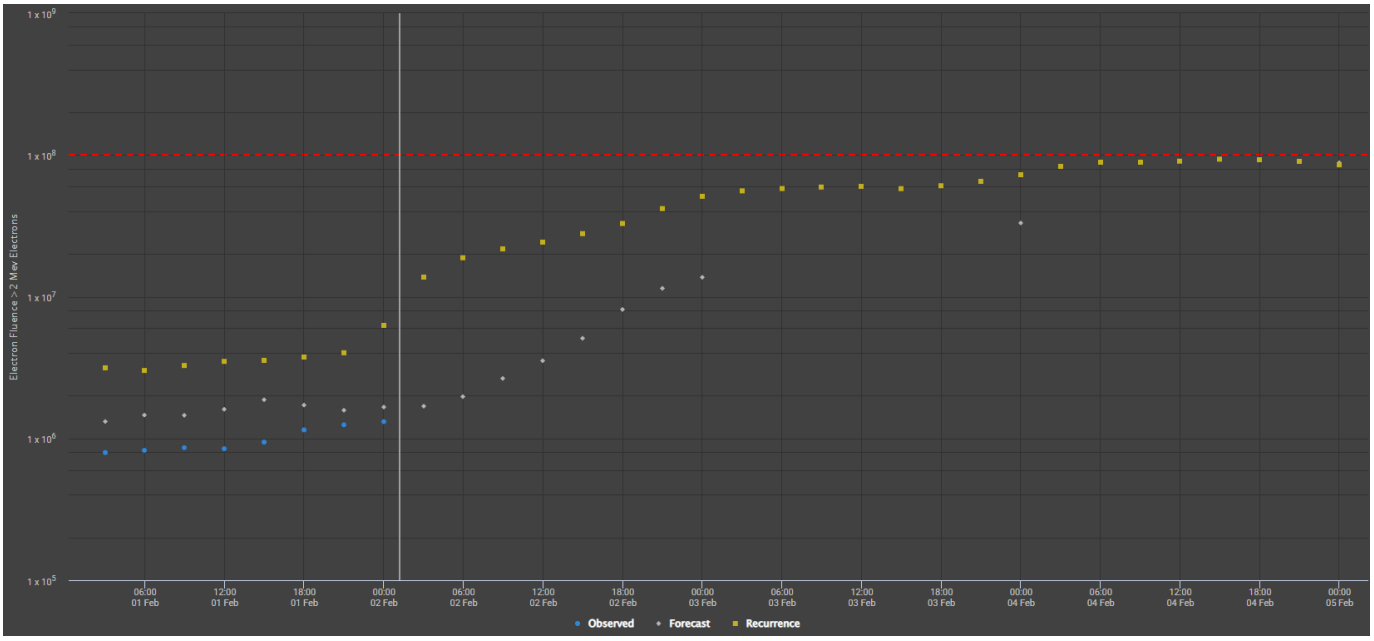
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 is currently at background levels with ongoing fast winds from CH11/+ likely compressing the Van Allen belts. Geomagnetic activity from the the ongoing HSS, as well as from the potential CME glance on Day 1 (02 Feb), will likely see some increasing charging of the Van Allen belts at lower orbits. As solar wind speed are expected to eases from Days 2-3 (03-04 Feb) onwards, the Van Allen belts should expand back towards GEO, potentially bringing an increase in flux at this orbit. Flux could rise to Moderate levels later in the period, with an increasing chance of reaching High at the diurnal peak.

The corresponding 24 hour fluence is expected to persist below the Active threshold Days 1-2 (02-03 Feb), but with an expected rising trend Days 3-4 (04-05 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period, in the absence of further CME activity. MOSWOC REFM output is currently thought to be providing reasonable guidance, although confidence is reduced due to uncertain CME impacts.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	25	50
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: Latest MOSWOC REFM output.



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